REE mineralisation in the Cummins Range Carbonatite, Western Australia

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The Cummins Range Carbonatite Complex (CRCC) lies on the southern margin of the Kimberley Craton in northern Western Australia. It comprises a sub-vertical stock, ~2 km in diameter, with a central calcite-dolomite carbonatite plug mantled by variably metasomatised pyroxenite [1]. The CRCC hosts low grade concentrations of secondary supergene U and REE and localised high grade primary REE mineralisation within the carbonatite [2].

The REE contents of co-existing apatite and carbonate in pyroxenite and carbonatite were determined to (i) investigate the petrogenetic relationship between the carbonatite and silicate components, and (ii) examine the proposed mechanisms for enriching REE in carbonatites such as fractional crystallisation and/or liquid immiscibility from an associated silicate rock. Both the pyroxenite and carbonatite have similar bulk LREE-enriched patterns but the carbonatite typically has higher chondrite normalised La/Yb. Sheared and hydrothermally altered carbonatite is further LREE-ennriched.

Trace element concentrations of phases were determined by LA-ICP-MS. Apatite, a major host of REE (ΣREE = 4953-6077 ppm), is ubiquitous across the complex and strongly LREE-enriched (La/Yb = 70-92). Carbonates have low REE abundances (ΣREE = 50-305 ppm). Accessory phases are rich in REE with perovskites highly LREE-enriched (La/Yb = 274-358) and zirconolites HREE-enriched (La/Yb = 2-3).

Experimental studies of REE partitioning between apatite and $CaCO_3$ melt show a broadly symmetric convex-upward Onuma parabola centred around Sm-Gd. However, the K_D^{REE} between apatite and carbonate of the CRCC reveals a parabola relatively enriched in LREE and depressed in HREE. Apatite/whole rock partitioning shows a similar pattern indicating HREE distribution is strongly influenced by early crystallising accessory phases, such as zirconolite (pyroxenite) and pyrochlore (carbonatite).

[1] Andrews (1990) *AusIMM* **14**, 711-713. [2] Downes *et al*. (2014) *Miner. Despos*. **49**, 905-942.